Safeguards at 40

Michael Anastasio

The fortieth anniversary of international safeguards offers a chance to reflect on this remarkable story of international security collaboration.

The concept of international safeguards on nuclear material and activities dates from Dwight Eisenhower's "Atoms for Peace" speech to the United Nations in 1953. The International Atomic Energy Agency (IAEA) has since its creation applied various technologies and methods to help ensure that nuclear material is not diverted from peaceful for improper uses. Its safeguards system pioneered on-site inspections and involved unprecedented, albeit limited, inroads into Member States' sovereignty.

For decades during the Cold War, international safeguards went as far as Member States' consensus on nuclear energy and nuclear nonproliferation, along with limits on technologies, would allow. These inspections were not intended to prevent diversion. Indeed, they were designed and administered to deal with only one path to nuclear weapons, that is, diversion to military purposes of material from declared peaceful nuclear activities. Safeguards can in principle deter and, should deterrence fail, detect the diversion of significant quantities of a nuclear-weapon-usable material. But the safeguards developed before the Treaty on the Nonproliferation of Nuclear Weapons (NPT) and then under NPT authorities looked only upon the "correctness" of a declaration.

With the NPT, however, it was increasingly seen as vital that international safeguards be as robust as possible--providing timely warning of diversion--to enable an effective international response. Accordingly, they evolved to meet the challenges posed by new technologies, new international undertakings and new threats.

A significant factor in the IAEA's continuing improvements in inspections effectiveness during this period was the system of support programs through which Member States contribute to technology advances and other activities.

Virtually all of the equipment used by inspectors was developed under such programs, and technical knowledge, training, equipment and facilities were provided.

The Los Alamos National Laboratory, working with domestic and international partners, was and remains a leader in this effort. The impact of the technology advances achieved on the basis of the system of support programs through which Member States contributed was striking.

Innovations in nondestructive assay equipment—including neutron coincidence counters for quantitative measurements of unirradiated plutonium…and gamma spectroscopy instruments for determining isotopics of plutonium and uranium—provided inspectors with rapid *in situ* determinations of the concentration, enrichment, isotopics and masses of nuclear materials that would be expensive and time consuming and, in some cases, impractical by other means.

Continuous unattended monitoring of activities in nuclear facilities—including video surveillance devices that monitor spent fuel ponds at reactors, core discharge monitors that monitor fuel movements in on-load reactors, and electronic seals that record the time of application—improved the efficiency of inspections by reducing the time spent by inspectors at facilities and the costs to the Agency and to operators.

In addition to technology advances during this period, safeguards were strengthened by innovations in procedures that enhanced effectiveness and efficiency. Examples include application of randomized inspections to verify the material flows at low-enriched uranium fuel fabrication plants and earlier reporting requirements for design information relating to new facilities.

As a result, the Agency was able to act in a rapid and flexible manner to handle unprecedented situations around the world, from South Africa to the former Soviet Union as the Cold War was ending.

However, the post-Gulf War Iraqi program, the terrorist attacks of 9/11, the discoveries of additional States under the NPT developing clandestine programs and the associated revelation of an extensive non-state nuclear procurement network have presented new challenges to international safeguards, and to the entire nonproliferation regime.

As it had in earlier decades, the IAEA has been transforming its safeguards system to address such issues, many of which it was never designed to handle, as well as to deal with the expected

growth in nuclear energy use such as that contemplated by the Global Nuclear Energy Partnership, or GNEP.

The IAEA is adopting a fundamentally new approach to implementing safeguards based on the strengthening measures developed in the 1990s and the lessons learned from Iraq, North Korea, Libya and Iran. It is recognized that an effective, strengthened international safeguards system, with a strong focus on searching for undeclared nuclear materials and activities, is essential to provide confidence that shared nuclear technologies and expertise, as well as nuclear materials themselves, are not being diverted to weapon programs. “Completeness” as well as “correctness” has become critical.

Central to the transformation is the Additional Protocol (AP), which is an important new tool and needs to be universally accepted as the basis for safeguards and a condition for exports. Although most states with significant nuclear activities have now brought the Additional Protocol into force, there remain a large number of states that have not yet ratified the Additional Protocol. The Agency and Member States are trying to remedy this situation, as well as the problem of the universality of comprehensive safeguards agreements.

Implementing the new measures in the Additional Protocol, as well integrating traditional NPT safeguards (INFCIRC/153) and new AP safeguards (INFCIRC/540), remains a work in progress. Fundamental to the new approach to IAEA safeguards is information acquisition, evaluation and analysis along with inspections. The new approach is designed to provide an evaluation of the nuclear program of a state as a whole and not only of its declared nuclear facilities.

In order to move in the right direction, there is a clear need for capabilities to detect undeclared nuclear facilities and also to address challenges posed by:

- large, increasingly complex new facilities, with high material throughputs;
- difficult-to-measure materials;
- harsh environments with high dose rates and temperatures;
- measurement of new isotopes and combinations of isotopes; and
- possible diversions without physical change to plant.

Addressing these and other challenges—both anticipated and unanticipated—will require a defense-in-depth approach that includes:

- state-of-the-art instrumentation and methodologies for materials measurement, accounting and tracking, including sensor platform integration;
- enhanced containment and surveillance, including portal and area radiation monitoring, and measures to assure the absence of materials or radiation signals;
- integration of access denial and transparency elements of physical protection and safeguards; and
- integration of traditional process monitoring with non-traditional indicators, such as detection of radiation signals where they should not be, questionable movement of equipment and people, etc.

To support such an approach, it is necessary to revitalize technology R&D and recreate a robust, flexible and adaptive technology base for next-generation, advanced safeguards technologies.

Given these challenges, it is clear that IAEA safeguards will continue to change in the future as they have evolved over the last four decades. As noted, there is an increased need for capabilities to detect undeclared nuclear facilities, the need for continuing improvements in safeguards at increasingly large and complex declared fuel cycle facilities and a desire for a more intensive involvement in applying safeguards in new roles.

Los Alamos is working on these and other issues--in collaboration with other labs and agencies--to help the United States and the international community prepare for an uncertain future.

Of course this evolution of safeguards must reinforce, and be reinforced by, other nonproliferation initiatives, careful growth in nuclear energy and other actions to address the changing security environment.

In sum, at a time when nuclear activities are increasing throughout the world, IAEA safeguards face new challenges. It is clear that IAEA safeguards must continue to change in the future as they have evolved over the last four decades.